MORPHOLOGICAL CHARACTERISTICS OF FRUIT ORCHARDS AND THEIR INFLUENCE ON SOIL PHYSICO-CHEMICAL PROPERTIES

Comment [D1]: 1.Title is not smart. The title should be rearranged: - EFFECT OF THE Morphology OF FRUIT ORCHARDS ON SOIL PHYSICO-CHEMICAL PROPERTIES in ----- place.

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ABSTRACT

Biophysical characteristics of 16-year-old fruit orchards and their influence on soil physico-chemical properties of sixteen-year-old fruit orchards established at Krishi Vigyan Kendra, Birouli, Samastipur (Bihar) were compared. Fruit orchards were Mango (*Mangifera indica) var*. Malda, Litchi (*litchi chinensis) var*. China and Aonla (*Emblica officinalis*) *var*. NA-7. An investigation was undertaken to evaluate the dynamics of Oxidisable Organic Carbon (Coc), SOC sequestration, Bulk Density (BD), pH and Electrical Conductivity (EC) in fruit orchards. All the orchards significantly improved SOC showing 12.9 to 44.6 % higher than that in open (without trees) and followed the order: Aonla> Litchi > Mango. The total SOC increased by 10 to 20 % at the surface and 15 to 35 % in the lower depths. The mean value of the pH for the both, surface and sub-surface soil in the fruit orchards and open varied from 8.58 (Litchi) to 8.68 (open). The value of EC of the surface soil in orchards showed 9 to 21 % reduction, whereas in the sub-surface soil it showed 14 to 36.7 % reduction when compared to open. Irrespective of the soil treatments the BD was significantly higher in the sub-surface soil (1.428 Mg m^{-3}) in contrast to the surface (1.412 Mg m^{-3}). The crown diameter of Mango, Litchi and Aonla orchards were 11.64 m, 8.61 m and 8.6 m and girth at breast height (GBH) varied from 9.53 m in Aonla orchard to 5.6 m in Litchi orchard. By and large, Aonla orchard may be considered as the best orchard production system from the standpoint of SOC build up and improvement in soil physic-chemical properties. Hence, its promotion and expansion as land-use practices in the calcareous belt of Bihar will be helpful for food security and mitigating climate change.

Keywords: Soil organic carbon, Soil Organic carbon sequestration, Soil Organic Carbon,Fruit Orchards.

INTRODUCTION

Growing of the perennial horticultural crops helps to improve and enhance the physico-chemical and biological conditions of the soil, augment the soil attributes, contribute to good soil quality and soil health. In comparison to the annual crop perennial crop sequester more organic carbon **(Bhavya *et al.*, 2017).** One of the options for reducing the rise of greenhouse gas (GHG) concentration in the atmosphere and thus possible climate change is to increase the amount of C removed by and stored in perennial plants. Soil plays an important role in global carbon cycle as it contains around three times more C than in atmosphere and 3.8 times more C than in biotic pool **(Zomer*et al.*, 2008).** Soil can either be a source or sink for atmospheric CO2 depending on land use and the management of soil vegetation **(Lal, 2004).**Soil organic carbon dynamics and storage is gaining importance nowadays because of its ability to mitigate the change in the climate, ameliorate the soil affected soil, maintain the global carbon balance and address the issues of the food security. Good farming practices attenuates CO_2 load in the atmosphere, makes the soil potential sink of carbon, improve soil fertility and productivity. Exemplary land use management practices and congenial and advantageous farming practices have potential to attenuate the carbon dioxide in the atmosphere, make the soil a net sink of carbon and improve the inherent capacity of the soil to supply nutrient to the plant. **(Lal, 2004).**Trees improve the ecosystem of the soil as heavy and continuous leaf litter fall, twigs branches addition to the soil,deep and extensive root system,translocation of immobile nutrient from the deeper layers of the soil profile and increase the availability, transformation and solubilization of insoluble complexes and ultimately improve the soil physiochemical properties of the soil. **(Allen *et al.*, 2004).**Although, sufficient reports on soil C dynamics and other soil properties in annual agricultural crop systems are known, these information in fruit orchard eco-systems is lacking and limited particularly in calciorthents of Bihar. Therefore, the present study was carried out to assess the variation in soil properties under Mango, Litchi and Aonla orchards after 16 years of their planting.

MATERIAL AND METHODS

The orchards Mango, Litchi, and Aonla orchard are established at Krishi Vigyan Kendra, Birouli under Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, and Bihar. Krishi Vigyan Kendra, Birouli at the coordinates 25° 58' 54" N latitude, 85° 40' 25" E longitudes and at 55 meter above mean sea level. The sum total climate is sub-tropical. The mean relative humidity ranged between 63% to 84%. The mean rainfall was observed highest in the month of July with an average of 646.8 mm.Totalnumber of treatment is 4 including 3 fruit orchards

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(Mango, Litchi, and Aonla) and Control with 5 replication. Design of the experiment is Randomized Block Design. Systematic soil sampling is done using soil augur from four distinct directions at two depths (0-15 and 15-30 cm) and at mid crown and periphery. Composite samples were obtained. Samples were further shade dried, grinded with wodden hammer through 2mm sieve and stored in polythene with proper labelling. The biophysical parameters of the soil were taken. Height (m) was measured by optical Reading Clinometer (PM-5/360 PC). DBH = Girth/ 3.14 was determined at the height of 1.37 m from tree base and crown width (m) measured on the ground in north-south and east-west directions with the help of measuring tape. Oxidisable soil organic carbon **(SOC)** was estimated with wet oxidation standard method by **Walkley and Black (1934)**. Total SOC was determined through oxidation with 0.4 N $K_2Cr_2O_7$ followed by titration with FAS **(Jenkinson and Ladd, 1981)**. TOC (%) = 10.67× (B – S)/B Where, B= Blank Titration (ml), S= Sample titration (ml).pHand EC was determined by method proposed by **Jackson, 1973** with soil: water ratio of 1:2. Bulk density (BD) was calculated by dividing the weight of oven dried soil by the volume of core used (**Black, 1965**)

$$\text{Bulk density } (Mg\ m^{-3}) = \frac{\text{The weight of oven dry soil (Mg)}}{\text{The volume of soil } (m^3)}$$

The volume of the soil was taken as the inner volume of the core sample, which was, in turn, calculated by $\Pi r^2 h$, where r- radius, h-height of the core.

STATISTICAL ANALYSIS:

The data generated was subjected to statistical analysis **(Gomez and Gomez, 1984)**. The soil properties of different orchard systems were tested for significant differences by two way analysis of variance. The orchard systems including open constituted first factor and the depths at which soil samples collected were the second factor.

RESULT AND DISCUSSION

Oxidisable SOC varied from 0.36 % (open) to 0.52% (Aonla) in upper surface of soil (0-15 cm) and 0.23% (open) to 0.32% (Aonla) at the lower soil depth (15-30 cm). Among the

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Comment [D9]: Rearrange grammatically treatments irrespective of the soil depths all the orchards significantly built up SOC showing 13 to 44 % more than that in open condition and followed the order: Aonla> Litchi > Mango. Improvement in the biochemical stability of the SOC in the agroforestry might be due to continuous addition of plant parts like litter, barks, branches, these cells are highly lignified **(Six *et al..* 2002).**The total SOC increased by 0.60 % to 1.6 % at the surface and 0.30 % to 1.28% in the lower depths. The value of total SOC in the fruit orchard at the surface ranged from 0.76 % to 0.83 % and at the lower profile the depth the value ranged from 0.55 % in mango orchard to 0.64 % in the Aonlaorchard.Thereason for increase in the TOC at the surface might be the residual effect of the shoot (leaf litters, twigs, stem, barks etc.) and shoot biomass that is returned to the soil.

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The soil pH reduction under the Mango orchard, litchi Orchard and Amla orchard was 0.23% ,0.48% and 1.31% in the surface and 0.14%,0.408% and 0.408% reduction in pH in subsurface was recorded over the control, respectively. On the other hand, irrespective of the treatments, surface soil was found to have significantly lower pH than that of sub-surface..Interaction effect between treatments and soil depths were statistically at par. The reduction in the soil pH might be due to the root exudates and dead root biomass. In the subsequent years with the growth of the trees, the decomposition of the leaf litter releases the weak organic acid that lowers the pH of the soil **(Das *et al.*, 2011).**

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The value of EC of the surface soil in fruit orchards varied from 0.26 (Aonla) to 0.30 dS/m (Mango) showing 8.5 %to 22.7 % reduction, whereas in the sub surface soil it varied from 0.19 (Aonla) to 0.24 dS/m (Mango) showing 13.9 % to 36.7 % reduction when compared to open. Reduction in the EC as compared to the control might be due to deep and extensive root systems of the fruit tree that enable the uptake of soluble salt from the soil and slightly reduce the concentration of soluble salt in the soil solution.Thevalue of bulk density varied from 1413 in Aonla to 1428 kg m^{-3} in the Mango orchard irrespective of the soil depths. No significant changes in BD by the fruit orchards might be due to calcareousness of the soil with very high percentage of free $CaCO_3$ that have decreased the effect of the organic carbon. Similar results have been also reported by **Laik et al. (2009)**while studying the effect of 18-year-old forest tree species on calciorthents.

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It was found that, among three types of trees, Aonla trees (9.4 m) were tallest and Litchi trees were shortest (5.65 m). Aonla trees (0.95 m) had highest diameter at breast height, while Litchi trees (0.84 m) had lowest diameter at breast height. The investigation revealed that crown diameter was the highest in Mango tree (11.66 m) followed by Litchi (8.62 m) and Aonla (8.58 m)**.**

CONCLUSION

All the orchards significantly built-up SOC showing 13 to 44 % higher than that in open (without trees) and followed the order: Aonla> Litchi > Mango. Plantation leads improvement of biological, physical and chemical properties of soil. Significantly higher total SOC up to the soil depth of 0-30 cm in 16-year-old Mango, Litchi and Aonla orchard indicated their potential as carbon sink. Highest significant improvement in total SOC under Aonla orchard in the top 0-15 cm of soil revealed the potential for carbon sequestration under this orchard. This type of phenomenon is very important as the leached bi-carbonate ions cannot be easily re-emitted to the atmosphere. Besides, the loss of carbonates from the surface soil (0-15 cm) would help reduce the calcareousness of the soil and other constraints related to the soil fertility.

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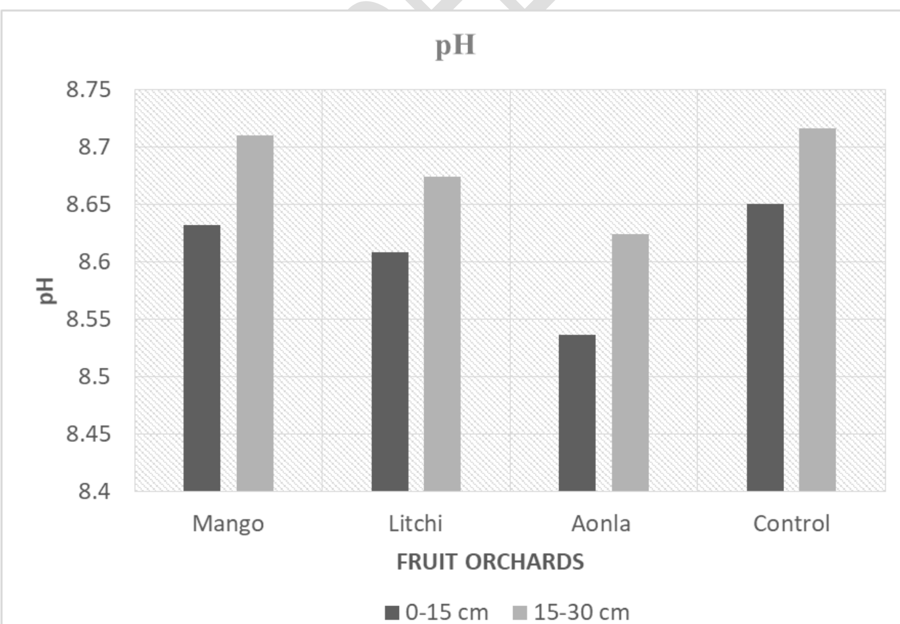

Fig. 1 Effect of 16-year-old fruit orchards on soil pH

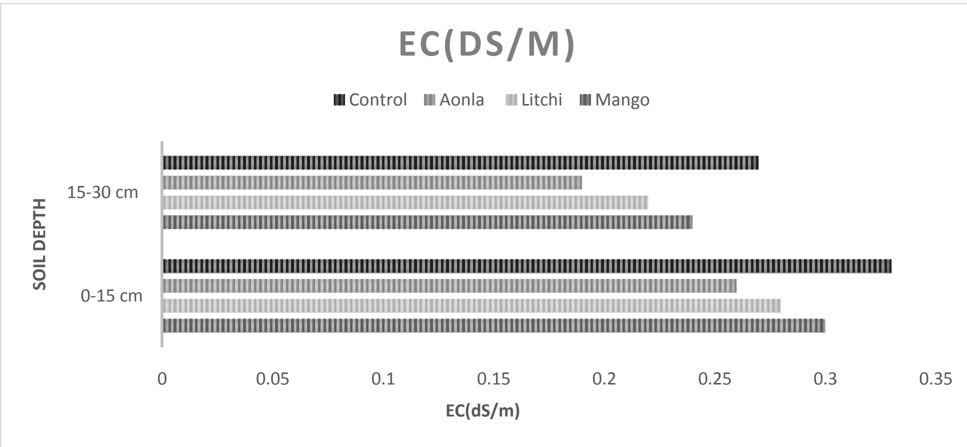

Fig. 2 Effect of 16-year-old fruit orchards on electrical conductivity (EC) of soil

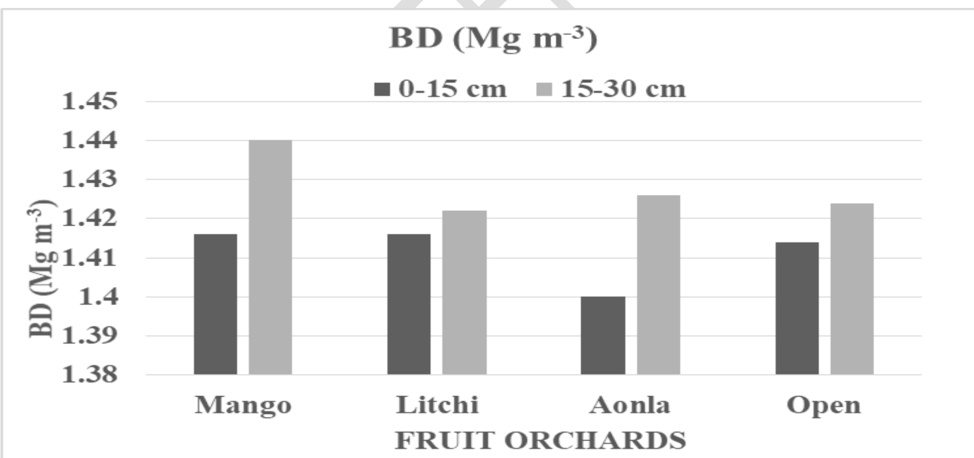

Fig.3 Effect of 16-year-old fruit orchards on Bulk Density (BD) of soil.

Table 1. Biophysical characteristics of Fruit Orchard

Sl. No.	Fruit trees	Height (m ± SE)	*GBH (m ± SE)	Crown diameter (m ± SE)
1.	**Mango (*Mangifera indica) var.* Malda**	8.86 ± 0.10	0.95 ± 0.08	11.65 ± 0.09
2.	**Litchi (*litchi chinensis) var.* China**	5.64 ± 0.09	0.83 ± 0.01	8.60 ± 0.02
3.	**Aonla (*Emblica officinalis*) *var*. NA-7**	9.46 ± 0.10	1.01 ± 0.02	8.57 ± 0.06

Table 2. Effect of 16-year-old fruit orchards on oxidizable SOC and total SOC

Treatment	**Oxidizable SOC (%)**			**Total SOC (%)**		
	0-15 cm	**15-30 cm**	**Mean**	**0-15 cm**	**15-30 cm**	**Mean**
Mango	0.43	0.26	0.34	0.76	0.56	0.66
Litchi	0.48	0.29	0.39	0.78	0.59	0.69
Aonla	0.52	0.32	0.42	0.83	0.64	0.73
Open	0.37	0.24	0.3	0.71	0.49	0.6
Mean	0.45	0.28		0.77	0.57	
Factors	C.D. (P≤0.05)		S.E. (m±)	C.D. (P≤0.05)		S.E. (m±)
Treatment	0.12		0.04	0.06		0.02

(T)				
Depth (D)	0.09	0.03	0.04	0.02
Interaction (T × D)	0.17	0.06	0.09	0.03